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DECEMBER 5.

The President, GENERAL ISAAC J. WISTAR, in the chair.

One hundred and thirty-eight persons present.

A paper entitled "Earthenware of Florida, Collections of Clarence B. Moore," by W. H. Holmes, was presented for publication.

DR. BENJAMIN SHARP made a communication on his recent visit to the Hawaiian Islands. (No abstract).

Heredity in the Social Colonies of the Hymenoptera.—At the meeting of the Academy held May 23 PROF. EDW. D. COPE, referring to the question of heredity in the social colonies of the Hymenoptera, remarked that perhaps the strongest case that can be made out against the theory of use-inheritance has been presented by Mr. W. P. Ball,* viz.: that of the variety of structure displayed by the neuter members of the colonies of ants and termites. Mr. Ball describes these briefly as follows:

"But there happens to be a tolerably clear proof that such changes as the evolution of complicated structures and habits and social instincts *can* take place independently of use-inheritance. The wonderful instincts of the working bees have apparently been evolved (at least in all their later social complications and developments) without the aid of use-inheritance nay, in spite of its utmost opposition. Working bees, being infertile "neuters," cannot, as a rule, transmit their own modifications and habits. They are descended from countless generations of queen bees and drones, whose habits have been widely different from those of the workers, and whose structures are dissimilar in various respects. In many species of ants there are two, and in the leaf-cutting ants of Brazil there are *three* kinds of neuters which differ from each other and from their male and female ancestors "to an almost incredible degree."¹ The soldier caste is distinguished from the workers by enormously large

*The Effects of Use and Disuse. Nature Series, 1890, P. 24.

¹Origin of Species, pp. 230, 232; Bates' Naturalist on the Amazons. Darwin "is surprised that no one has hitherto advanced the demonstrative case of neuter insects, against the well-known doctrine of inherited habit, as advanced by Lamarck." As he justly observes, "it proves that with animals, as with plants, any amount of modification may be effected by the accumulation of numerous, slight, spontaneous variations, which are in any way profitable, without exercise or habit having been brought into play. For peculiar habits confined to the workers or sterile females, however long they might be followed, could not possibly affect the males and fertile females, which alone leave any descendants." Some slight modification of these remarks, however, may possibly be needed to meet the case of "factitious queens," who (probably through eating particles of the royal food) become capable of producing a few male eggs.

heads, very powerful mandibles, and "extraordinarily different instincts. In the driver ant of west Africa one kind of neuter is three times the size of the other, and has jaws nearly five times as long. In another case "the workers of one caste alone carry a wonderful sort of shield on their heads." One of the three neuter classes in the leaf-cutting ants has a single eye in the middle(?) of its forehead. In certain Mexican and Australian ants some of the neuters have huge spherical abdomens, which serve as living reservoirs of honey for the use of the community. In the equally wonderful case of the termites, or so-called "white ants," (which belong, however, to an entirely different order of insects from the ants and bees) the neuters are blind and wingless, and are divided into soldiers and workers, each class possessing the requisite instincts and structures adapting it for its tastes. Seeing that natural selection can form and maintain the various structures and the exceedingly complicated instincts of ants and bees and wasps and termites in direct defiance of the alleged tendency to use-inheritance, surely we may believe that natural selection, unopposed by use-inheritance, is equally competent for the work of complex or social or mental evolution in the many cases where the strong presumptive evidence cannot be rendered almost indisputable by the exceptional exclusion of the modified animal from the work of reproduction."

"Ants and bees seem to be capable of altering their habits and methods of action much as men do. Bees taken to Australia cease to store honey after a few years' experience of the mild winters. Whole communities of bees sometimes take to theft, and live by plundering hives, first killing the queen to create dismay among the workers. Slave ants attend devotedly to their captors, and fight against their own species. Forel reared an artificial ant colony made up of five different and more or less hostile species. Why cannot a much more intelligent animal modify his habits far more rapidly and comprehensively without the aid of a factor which is clearly unnecessary in the case of the more intelligent of the social insects."

The explanation of this phenomenon will be probably some day found by paleontologic discovery. We may suppose, on the basis of discoveries already made in other animals, that the primitive ants and termites presented homogeneous colonies, and that the varied structures which they present to-day have been primarily due to the usual process of specialization through use-inheritance. It is reasonable to suppose that the varied functions of the different members of the community have modified the structures of the parts essential to their performance. It is probable that the earliest ants in an early geologic period, became soldiers under the usual exigencies of their struggle for existence, and having thus secured a place in the economy of nature, certain members of the communities underwent degenerative changes, appropriate to their respective functions, of a

less exacting character. In a second stage of evolution the community would present the character of a family of varied forms all of whose members would produce any or all of the types of form to be found in it, under slight diversities of condition, just as now, all species produce young of two sexes. The differences between the members of an ant community are considerable in appearance, but not so great essentially as that between sexes. Finally, in a third stage of the history, the function of reproduction came to be the special office of a few members of the community. This may have been due to a deficiency of food accessible to certain individuals aborting the reproductive powers; but whatever may have been the cause, a majority of individuals became sterile. The reproducing members of the community, however, have continued to produce all of the forms of the community. They produce sterile workers and soldiers, sometimes of several forms, through hereditary influences. But this, says Mr. Ball, is evidence that inheritance can have no share in the process. He believes that each one of the structural types of the community is produced by the treatment accorded to the young by the workers, *each generation for itself*. How excessive additions to structure can be produced by starvation, he does not attempt to show.

As we have seen that the embryonic and paleontologic histories distinctly negative the idea that each generation has been produced by itself without inheritance, let us endeavor to read the riddle in the light of the knowledge we have gained from paleontology. We assume that the most specialized types, the soldiers, represent the fertile type of the species in Liassic time, when the family first appears, or soon after. The process of change into workers and breeders has been degenerative. In ants, as in the case of the many other animals, slight differences in the supply of nutritive energy may prevent or produce these degenerative processes, as it appears to do in the case of the production of the sexes. (Experiments on lepidopterous larvæ have shown that excessive food supply produces females and deficient supply produces males). In bees, the larvæ of the female (queen) receive the largest food supply; those of the males less; and those of the neuters the least of all. How the food supply came to be varied so as to produce the several types, in accordance with the exigencies of the community, is a question to be solved by future research. Perhaps it was due to variations in the supplies available at particular times of the year; and perhaps the ants thus acquired a habit of feeding and came to practise it intelligently. It is enough for the present purpose to have shown that it is more probable that the basis of the entire community, the original fertile soldier, acquired his characters in the usual way: by use, and that all other forms have been derived from him by inheritance, modified by disuse or degeneracy, under the influence of variations in the food supply.